Nuclear Power Generation: Spent Fuel Management

Siro Genolet - Electromechanical Engineering Student
Universidad Tecnológica Nacional-Facultad Regional Paraná
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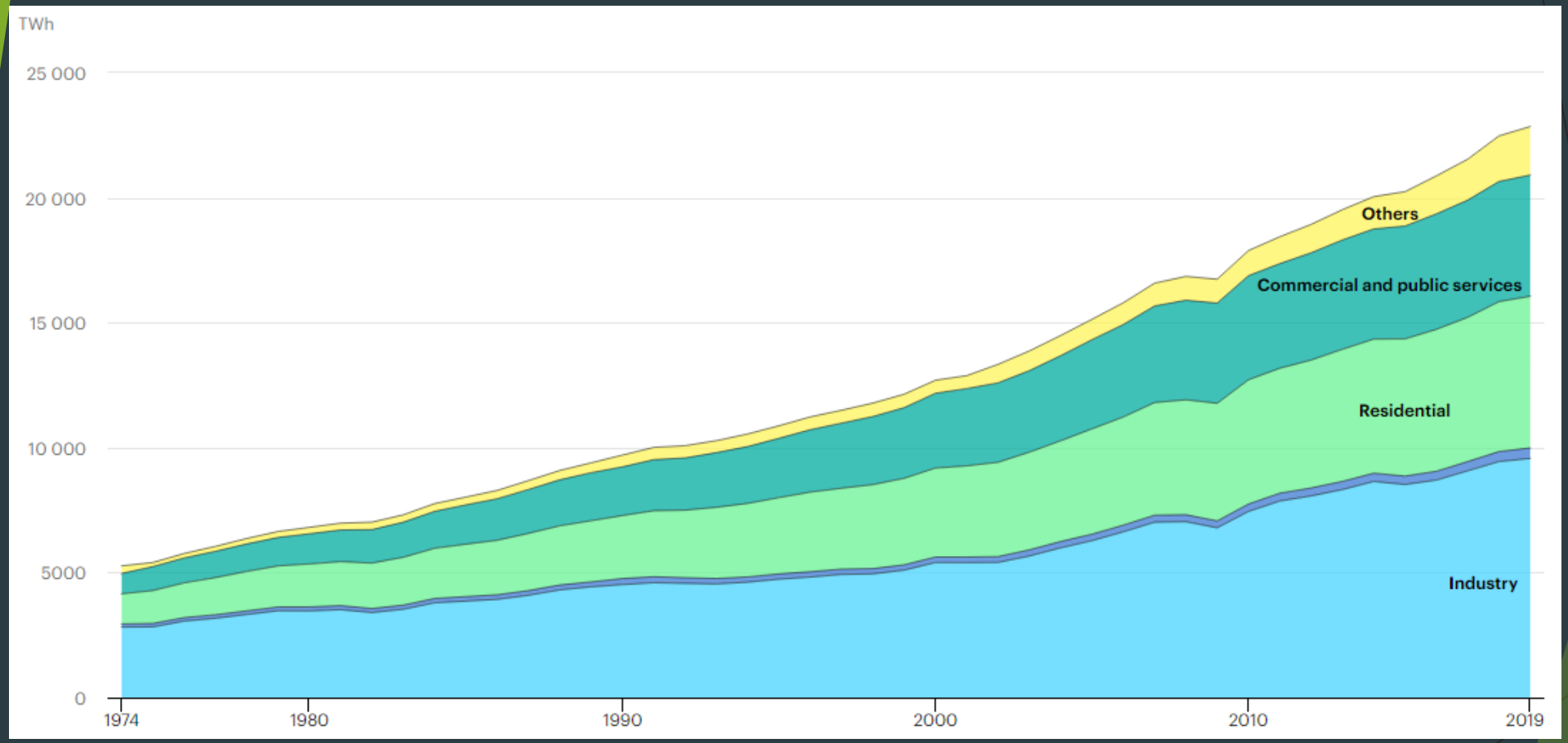
Nuclear Power Generation: Spent Fuel Management

Introduction



World´s electricity consumption from 1974 to 2019 [1].

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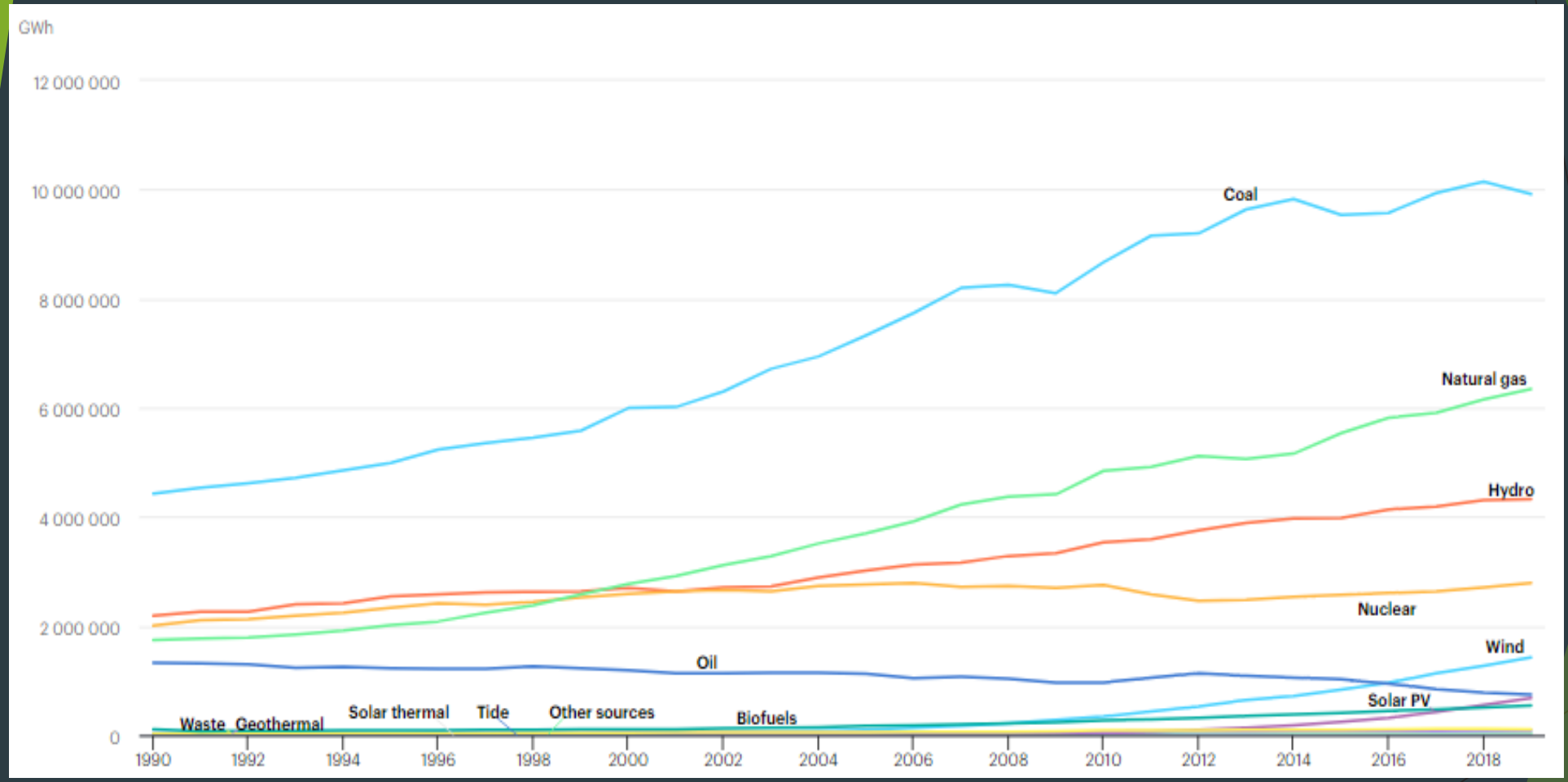

World´s electricity production share from 1990 to 2019 [9].

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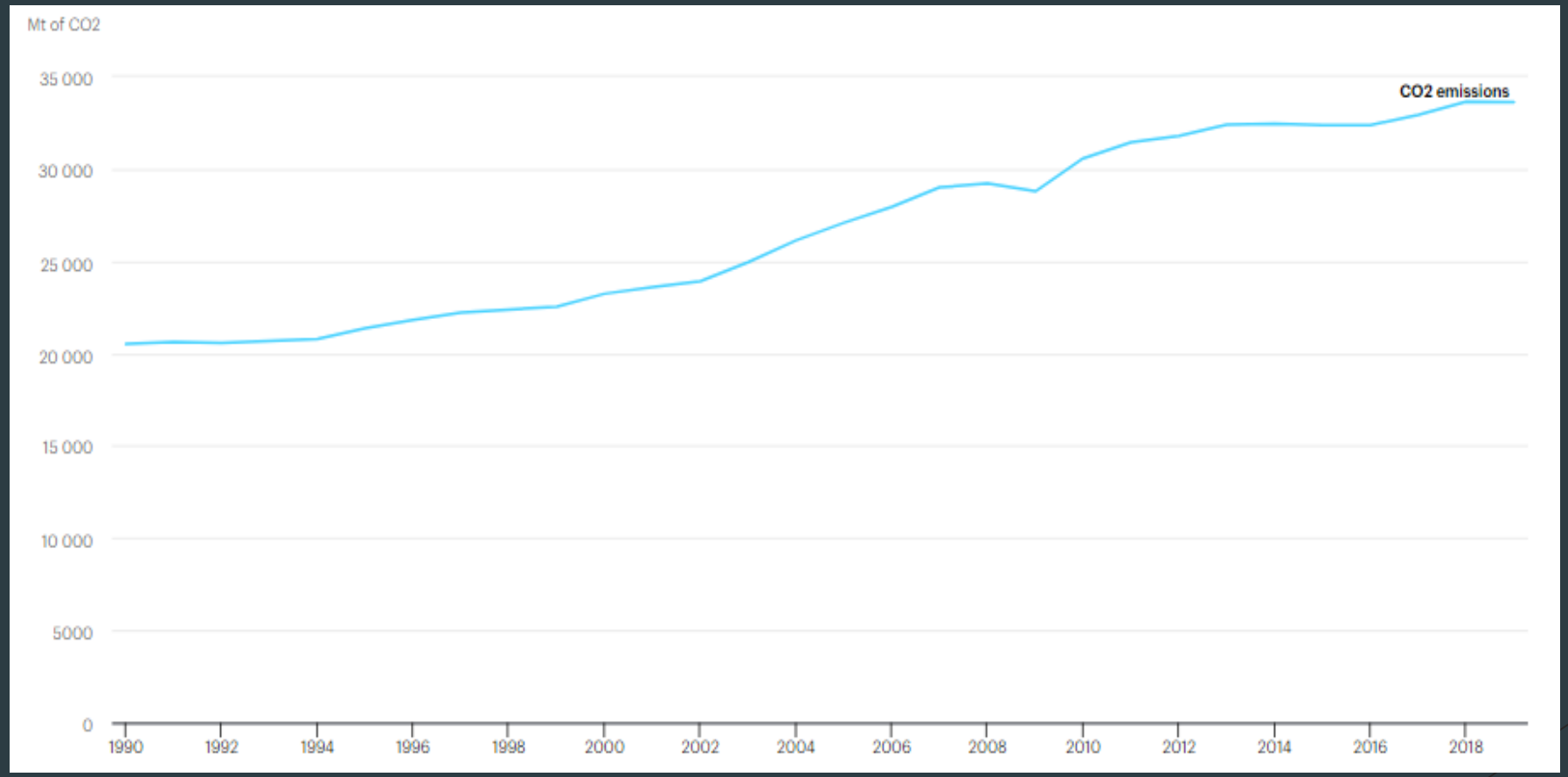

Carbon dioxide emissions from 1990 to 2019 [2].

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Introduction

According to UN and their SDG # 7, a clean, safe and affordable source of energy is needed.

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Introduction

Renewable sources rely on weather so base load power plants are needed.

Some examples of base load power plants are:

-Thermal power stations
-Hydroelectric power plants
-Nuclear power plants

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Introduction

Nuclear energy is:

- -Clean
- -Safe
- -Reliable

But it produces radioactive waste.

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Map of the presentation:

Nuclear fuel cycle:

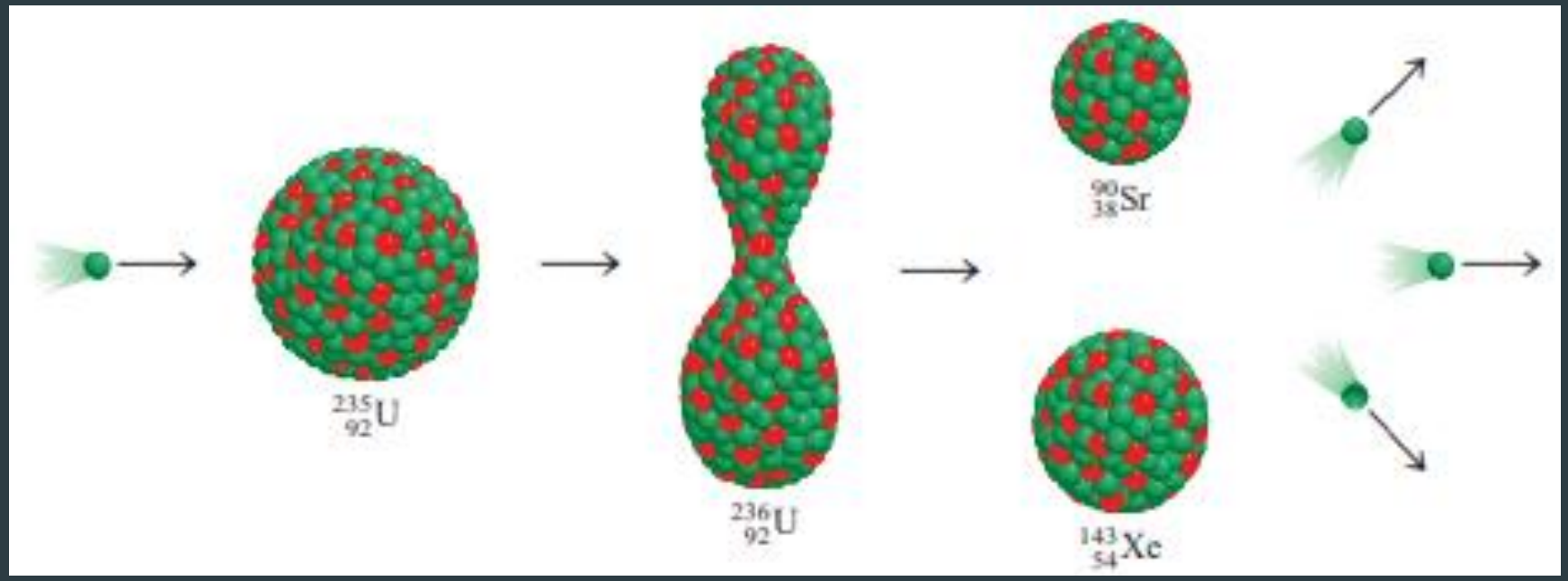
- -Fission
- -Nuclear reactors
- -Nuclear fuels
- -Spent fuel

Spent fuel management in different countries:

- -Types of waste
- -Basics about storage
- -France
- -China
- -Russia
- -United States
- -Argentina

Nuclear Fuel Cycle:

Fission:



Uranium-235 fissioning [3]

Nuclear Fuel Cycle:

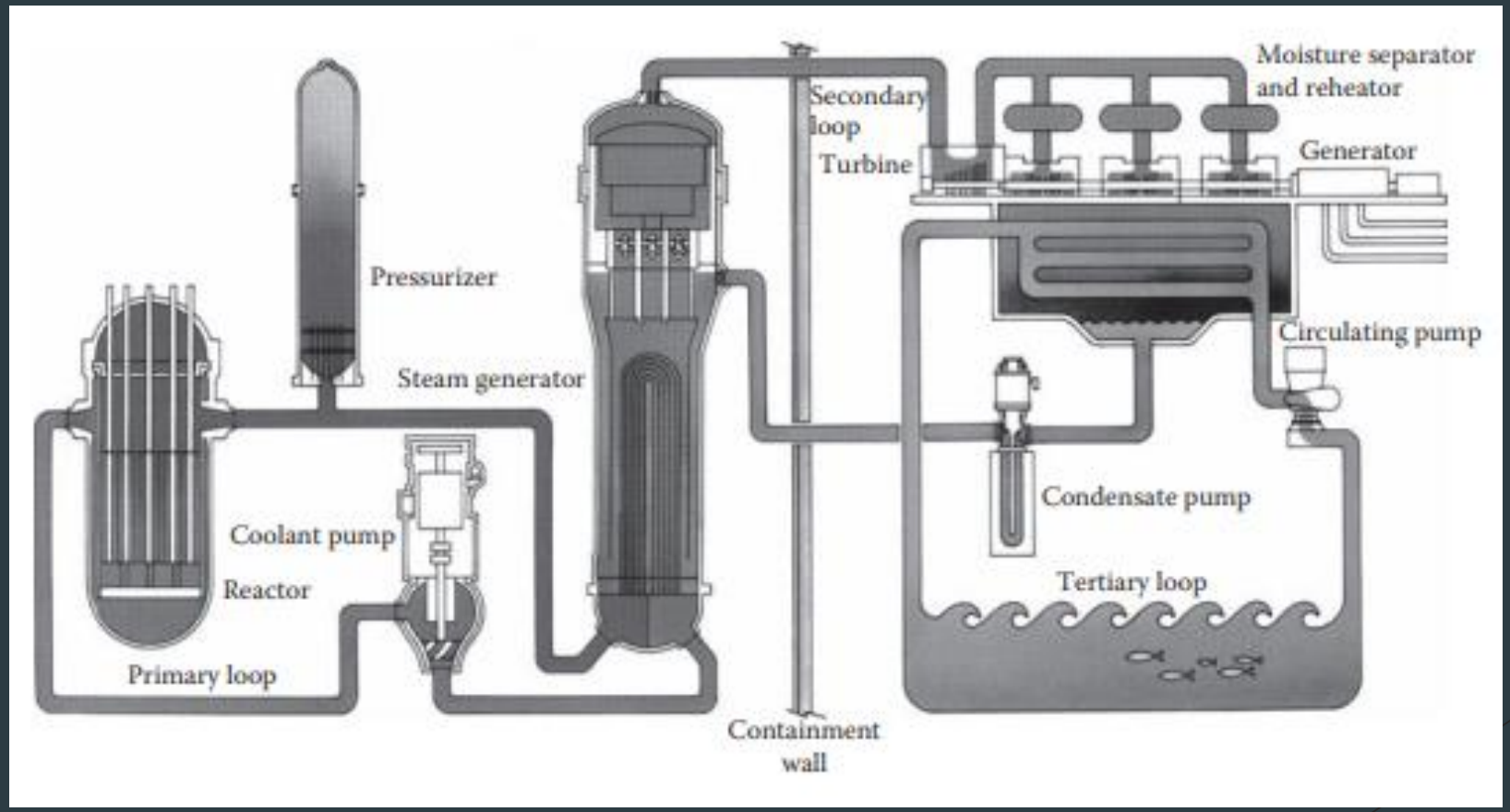
Fission:

Fissile nucleus: A nucleus that can undergo fission upon absorbing a slow neutron

Mainly: U-235, Pu-239

Nuclear Fuel Cycle:

Nuclear reactors in power plants use the heat from fission to produce steam to rotate turbines



Tipical PWR power plant [4]

Nuclear Fuel Cycle:

Nuclear Fuels:

Usually made of UO2 pellets, arranged in fuel assemblies [4].

Nuclear Fuel Cycle:

Spent Fuel:

At the end of the fuel cycle, there are changes in the fuel composition [5]:

New Fuel		Spent Fuel	
Isotope	Percent	Isotope	Percent
U-238	96.7	U-238	94.3
U-235	3.3	U-235	0.81
		U-236	0.51
		Pu-239	0.52
		Pu-240	0.21
		Pu-241	0.10
		Pu-242	0.05
		Fission Products:	3.5

Spent Fuel Management:

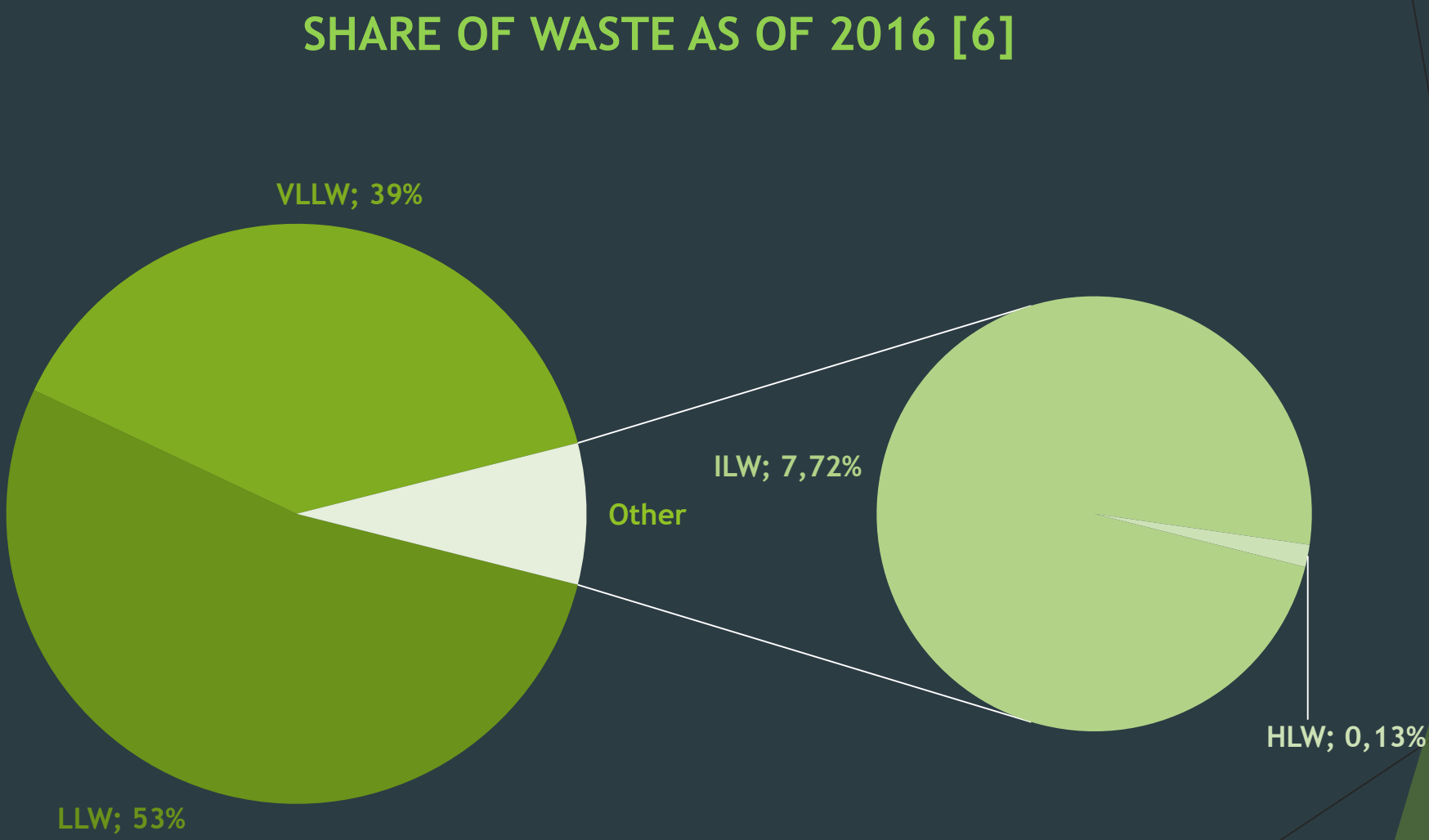
Kinds of radioactive waste:

-High Level Waste (HLW): Short-lived isotopes, highly radioactive

-Intermediate Level Waste (ILW): Long-lived isotopes, not as radioactive as HLW

-Low Level Waste (LLW): Small concentrations of actinides or FP, no shielding needed

Spent Fuel Management:



Spent Fuel Management:

Wet Storage: First stage after removing SNF from the reactor

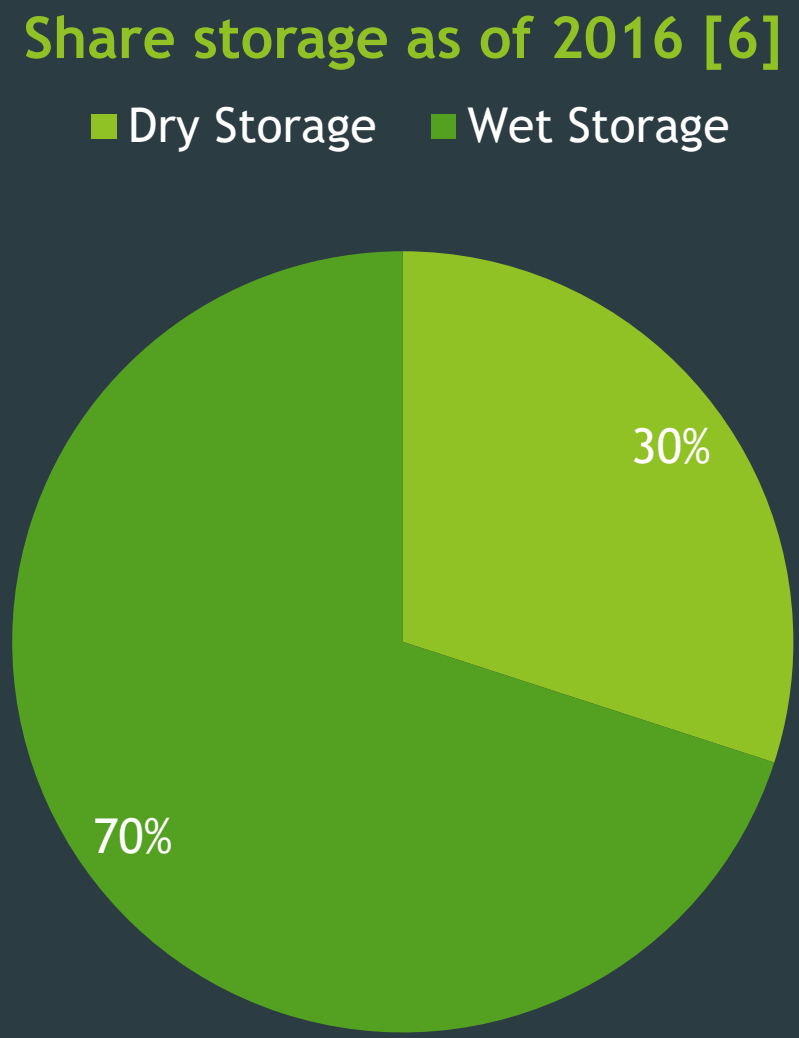
AFR in Sweden [6]

Spent Fuel Management:

Dry Storage: This stage comes after the cooling-down of SNF

Switzerland [6]

Spent Fuel Management:



Spent Fuel Management:

Reprocessing allows recycling SNF and shortens the storing time for fission products

THORP, UK [7]

Spent Fuel Management:

Final Disposal: Last stage in SNF management

Yucca Mountain, USA [8]

Spent Fuel Management in France:

France is currently:

- -Reprocessing its spent fuel
- -Using MOX in some of its reactors
- -Storing radioactive waste and SNF in interim storage

France is aiming to:

- -Be able to reprocess its spent fuel multiple times
- -Achieve a fully closed fuel cycle
- -Build a geological repository in the northeast of the country

Spent Fuel Management in China:

China is currently:

-Reprocessing spent fuel on a non-industrial scale

-Using MOX in some of its experimental reactors

-Storing SNF and radioactive waste in interim storage

China is aiming to:

-Be able to reprocess its spent fuel multiple times

-Achieve a closed fuel cycle by using thermal reactors, ADR and fast reactors

-Build a geological repository

Spent Fuel Management in Russia:

Russia is currently:

- -Reprocessing its spent fuel
- -Using MOX in some of its reactors
- -Storing radioactive waste in interim storage
- -Testing REMIX fuel
- -Building a centralized storage facility with a pilot reprocessing centre, and a laboratory to develop final disposal technologies

Russia is aiming to:

- -Be able to reprocess its spent fuel multiple times
- -Achieve a closed fuel cycle
- -Build a geological repository

Spent Fuel Management in The United States:

The United States is currently:

-Storing spent fuel in interim storage

The United States is aiming to:

-Build a geological repository in Yucca Mountain, Nevada

Spent Fuel Management in Argentina:

Argentina is currently:

-Storing spent fuel in interim storage

-Deploying a new ASECQ facility in Atucha I NPP; there is already an ASECQ facility in Embalse NPP

-Researching to decide whether to reprocess or to dispose of the SNF

Argentina is aiming to:

-Build another ASECQ to store SNF from both Atucha I and Atucha II

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Conclusion

- Reprocessing allows for a decrease in the amount of radioactive waste, at the same time it helps save on uranium.
- Disposing of the SNF without being reprocessed is not a responsible policy, since it leaves a complex issue for the future generations to solve.

Engineers all around the world must work together to improve current technologies and make them safer and more accessible for developing countries.

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